of the perturbations of the small planets for long intervals of time.

The VALZ prize, value, 460 francs, to M. CONIEL, a computer in the French Bureau of Longitudes, for the calculation of the orbits of 13 asteroids, and for other valuable computations.

The JANSSEN prize, a gold medal, to Professor GEORGE E. HALE, Director of the YERKES Observatory, University of Chicago, for successfully photographing the solar faculæ and prominences with the photoheliograph; for establishing an important new observatory, and for liberally contributing his personal resources to the needs of science. W. W. C.

## A BRIEF REVIEW OF FROST'S TRANSLATION OF SCHEINER'S "DIE SPECTRALANALYSE DER GESTIRNE." *

About the year 1888 astronomical spectroscopy began to undergo a remarkable development. This development was characterized by rapidity, completeness and accuracy. It was due to several causes, among which we may mention: the application of photography; the construction of large telescopes; spectroscopes planned to yield the maximum efficiency in the particular lines of work undertaken; and, above all other causes, systematic work. As examples of this, it is sufficient to mention: VOGEL'S photographic determinations of stellar motions in the line of sight, by means of a spectroscope specially designed for that problem; the wholesale discovery of interesting and important objects by means of their photographed spectra at HARVARD College Observatory; ROWLAND'S improvements in diffraction gratings and his work on the solar spectrum; and KAYSER and RUNGE'S accurate determinations of wave-lengths in the spectra of the elements.

In the old astronomy the attainment of accuracy in making observations required that corrections for refraction, parallax, etc., be rigorously applied, and led to greater refinements in all lines of investigation. The working astronomer was obliged to use a great variety of formulæ in reducing his observations and in utilizing his own and previous results. Such handbooks as BRÜNNOW'S and CHAUVENET'S, WATSON'S and OPPOLZER'S,

* A treatise on Astronomical Spectroscopy, being a translation of "Die Spectralanalyse der Gestirne," by Professor Dr. J. SCHEINER, assistant at the Royal Astrophysical Observatory at Potsdam. Translated, revised and enlarged, with the coöperation of the author, by EDWIN BRANT FROST, M. A., Assistant Professor of Astronomy in Dartmouth College, Boston, 1894. GINN & Co.

fortunately became available for his use. Similarly, the attainment of accuracy and the employment of new methods in celestial spectroscopy led every working astrophysicist to feel the pressing need of a handbook which would contain all the necessary formulæ, theories and results of previous observations, in a shape convenient for use. Up to 1890 there was no such book. Just as an elementary descriptive work on astronomy, intended for the high-school or for popular reading, is not adapted to the requirements of the working astronomer, so the excellent popular treatises on spectrum analysis by ROSCOE and by SCHELLEN are not of much use to the investigator in astrophysics. Happily, Professor SCHEINER, in 1890, was impelled to undertake the preparation of a book which should satisfy the requirements of the investigators; and, in his "Die Spectralanalyse der Gestirne," he succeeded admirably. The experience and position of the author, as Professor VOGEL'S assistant at Potsdam, enabled him not only to include those methods and principles required in refined work, but also to assign, with very few exceptions, the proper weight to observations made elsewhere. Those are the two most important characteristics of the book; characteristics, by the way, which can come only from long experience in making observations.

The hearty reception given to Professor SCHEINER'S handbook induced Professor FROST to increase its usefulness to the large number of English-speaking people who are interested in the subject, by translating, revising and enlarging it. The translating, which has been admirably done in pure and simple English, is but a small part of the work. The necessary revision was slight. It was in adding the results obtained in the years 1890–1893 inclusive that the principal task of the translator lay. That there have been great advances since 1890 is best shown by going through the book and marking those parts added by Professor FROST. That the translator has added the new matter most skilfully and judiciously is shown by the homogeneity of the old and the new portions. A list of the principal additions made by FROST is very encouraging. They are

(1) The properties of ROWLAND'S concave gratings.

(2) MICHELSON'S interference methods of spectroscopic measurements.

(3) HALE'S spectroheliograph, and his photographs of the solar faculæ and prominences.

(4) ROWLAND'S table of chemical elements present in the Sun.

(5) Extension of YOUNG'S table of chromospheric lines into the ultra-violet, by HALE and DESLANDRES.

(6) New lines observed at the LICK Observatory in nebular spectra.

(7) HARVARD College Observatory list of stars containing both bright and dark hydrogen lines.

(8) BELOPOLSKY'S studies on *β Lyræ.*

(9) WOLF-ROYET stars discovered at HARVARD College Observatory, and their spectra as observed at LICK Observatory.

(10) Observations of *Nova Aurigæ* at various observatories.

(11) Theories of new stars.

(12) Tables for the reduction of spectroscopic observations of motions in the line of sight.

(13) The Potsdam list of stellar motions in the line of sight.

(14) KEELER'S motions of nebulæ in the line of sight.

(15) ROWLAND'S new tables of standard wave-lengths in the solar spectrum, replacing the Potsdam list.

(16) KAYSER and RUNGE'S wave-lengths of selected lines in the arc-spectrum of iron, replacing THALÉN'S list.

(17) YOUNG'S partial revision of the chromospheric lines.

(18) Extensions in nearly every direction.

The book is divided into four parts:

Part I relates to Spectroscopic Apparatus, such as prisms, cylindrical lenses, slits, micrometers, gratings, etc., and describes a few of the principal spectroscopes now in use.

Part II, relating to Spectroscopic Theories, treats first of KIRCHHOFF'S law of the relation existing between emission and absorption phenomena of light; and, secondly, of DOPPLER'S principle of line displacements due to motion in the line of sight.

Part III, taking up nearly one-half the volume, is an admirable statement of the Results of Spectroscopic Observations. It treats of the Sun, Planets, Comets, Nebulæ, the Stars, the Aurora and

Zodiacal Light, the determinations of motion from the Displacement of Spectral Lines.

Part IV contains Spectroscopic Tables.

An Appendix, of 46 pages, is a Bibliography of Astronomical Spectroscopy.

While the work is intended as a handbook for investigators and as a text-book for special students, the general student of astronomical spectroscopy will find the whole of Part III, and many other portions, to be of great interest to him. Of the book as a whole, and of the treatment of details, there is very little to criticise adversely. There are a few minor points, however, which might be improved, or might mislead the general reader, and we shall point them out:

*First.*—The book would be better adapted to the requirements of students if methods of adjustment, principles concerning the efficiency of spectroscopes and other data were more systematically presented.

*Second.*—We miss descriptions of many recent spectroscopes and details of apparatus which are unquestionably of greater utility than some of those which are minutely described.

*Third.*—In the treatment of the spectrum of the solar corona, there is no mention of the diffraction effect as observed by HASTINGS and KEELER. The chapter on the Sun is very incomplete, probably necessarily so, and we are led to wish that YOUNG'S excellent book on "The Sun" was brought up to date.

*Fourth.*—The student who wrestles with portions of the last paragraph on page 198 must wrestle indeed. Why not change "more refrangible" to "less refrangible," and omit the remainder of that paragraph? These points are contained both in the German text and translation.

*Fifth.*—The last paragraph on page 199 contains some statements which are not established.

*Sixth.*—LOCKYER is entitled (on page 228) to the credit of first photographing some of the hydrogen lines in the *Orion* nebulæ, in February, 1890.

*Seventh.*—The bright H$\beta$ line in $\phi$ *Persei* (on page 257) was first observed, I believe, by ESPIN. The H$\alpha$ line was also observed to be bright at LICK Observatory in 1892.

*Eighth.*—It seems to me that some of the difficulties in the way of explaining the spectrum of *Nova Aurigæ* have not received adequate recognition. For instance, the large amount of detail shown on BELOPOLSKY'S negatives, described on page 289, is not to be explained away by Professor VOGEL'S suggestion that it may be due to changes in the spectroscope during the exposure. BELOPOLSKY'S comments on that suggestion, in *Astronomische Nachrichten*, No. 3184, make it exceedingly probable that the details are real features of the spectrum. May they not be accounted for by the fact that BELOPOLSKY used greater dispersion than the other observers? Again, some of VOGEL'S photographs show that the different hydrogen lines were not alike in structure and in displacement. Compare, for instance, his Hδ and Hε groups of March 3d and 4th. The displacements are very different. These, and other important difficulties, have not yet been adequately considered.

*Ninth.*—The Bibliography of Astronomical Spectroscopy in the German original had its usefulness seriously impaired by the *extraordinary* number of errors it contained. The translator has removed many of the errors, but, unfortunately, several still remain. For example, on page 448, "COPELAND, R. The spectrum of comet 1882a. Copernicus **2**, 255." should read "COPELAND, R. Spectroscopic observations of comets III and IV, 1881 ; comet I, 1882, and the great comet of 1882. Copernicus **2**, 225–245." Likewise, on page 452, line. 19, the numbers "363–394" should be "366–370."

The portions of the book relating to comets passed through the press too early to include the photographic spectra of comets *b* 1893 and *b* 1894, which extend our knowledge in that direction very considerably. It is likewise unfortunate that the 1893–'94 observations of the *Orion* nebula and the stars contained in it could not be utilized in the translation. The recent observations of *β* and *ε Orionis* show that the interesting line $D_3$ is dark in those stars—a fact which controverts the statement in lines 6–7, page 251.

While the responsibility for the treatment of all observations made since 1890 rests upon Professor FROST, an opportunity was given to Professor SCHEINER, in the preface, to express his dissent from FROST'S views, and to make additional comments. Some of SCHEINER'S notes are very suggestive and valuable. One cannot avoid being surprised, however, by his unsafe logic

used in note (7). Dr. SCHEINER does not believe it possible that dark lines can exist in the spectrum of γ *Cassiopeiæ*, as none have ever been seen in numerous photographs taken at Potsdam! Nevertheless, dark lines have been observed visually and photographically by KEELER, photographically at HARVARD College Observatory, and photographically at LICK Observatory.

Similarly, the doubts expressed by Professor SCHEINER, in notes (1), (8), (9), will not be sustained; on the contrary, the statements made by the translator will prevail.

While, perhaps, more attention has here been called to the book's weak points than to its strong points, my criticisms have not been made in any hostile spirit. The points which can be criticised unfavorably constitute an exceedingly small part of the book. The translation takes its place as the standard work, not only in English-speaking countries, but in all countries where astrophysical studies are prosecuted. The volume should be found in the library of every one who is interested in the details of celestial spectroscopy. W. W. C.

## CHANGE IN THE LATENT IMAGE OF AN EXPOSED DRY PLATE.

In October, 1894, while developing some CARBUTT B plates which had been exposed on the Sun in the months of June to October, I was led to suspect a change in the latent photographic image, and some of the same plates were exposed on November 1, for the purpose of determining the matter. These experimental plates were developed on January 15 and February 1. They show that the image had entirely disappeared in all except one case, and that was *extremely* faint. Every precaution was taken to eliminate accidental changes. From two exposures on the same plate, made November 1, 1894, and February 2, 1895, with the images overlapping, it is apparent that the exposed part fully recovered its sensitiveness in the interval, as the later exposure was of full density (including the portion which lapped over the first exposure); the first image being extremely faint. The change may be peculiar to that particular kind of plate or lot of plates, as a similar exposure on a CARBUTT A plate seems to show no such change. C. D. PERRINE.

LICK OBSERVATORY, February 2, 1895.